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Estimates for the nebular emission from r-process elements

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The origin of heavy r-process elements in the universe is still a matter of great debate, with a confirmed scenario being neutron star (NS) mergers. Additional relevant sites could be specific classes of supernovae (SNe), such as Type Ib/c, where a central engine pushes neutron-rich material outwards, contributing to the ejecta of the massive exploding star. We investigate our ability to infer the production of heavy elements in such events, on the basis of the observed electromagnetic (EM) nebular emission.
We solve the steady-state ionization, level population, and thermal balance, for ejecta in non-local thermodynamic equilibrium (NLTE), in order to explore the role of heavy elements in cooling the gas, and in the emergent spectrum. We find that heavy elements can dominate the cooling process of the nebula if they constitute more than ~10% of the total ejected mass, especially for kinetic temperatures above ~5000 K. While such an amount seems unlikely to be produced in many Type Ib/c SNe, already a few 0.1% of the total mass could be instead sufficient to leave a detectable imprint in the late infrared (IR) spectrum, which would be relatively clean from emission from lighter elements.

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